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Better Conditions for Releases of the Egg Parasitoid, *Trichogramma evanescens* West. for Controlling the Lesser Sugarcane Borer, *Chilo agamemnon* Bles. in Sugarcane Fields in Minia region

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ABSTRACT

The present work was carried out at Mallawi region, Minia governorate during the two successive seasons, 2005/06 and 2006/07 to chose optimum timing, distances and number of releases of the egg parasitoid, *Trichogramma evanescens* West. against the lesser sugarcane borer, *Chilo agamemnon* Bles. in sugarcane fields. Flight of the sugarcane moths was weekly monitored by electrocuting light trap in treated sites and untreated ones.Highest parasitism rates (83.78 and 85.95%) on *Chilo* eggs by *T. evanescens*, highest reduction percent of total infestation with sugarcane borer (63.44 and 65.43%) and highest cane yield (47.2 and 48.6 ton/fed.) were obtained when *T. evanescens* releases were during June 6th (around moths peak of the first generation of the pest). Lowest parasitism rates (50.31 and 54.71%), lowest reduction percent in total infestation (18.28 and.15.67%) and the lowest cane yield (39.6 and 41.4 ton/fed.) were obtained when the timing of *T. evanescens* releases were during August 20th (the second generation of the sugarcane borer). On other hand, releasing of egg parasitoid, *T. evanescens* at rates of 30000–120000 individuals/fed with distance 10 -20 meters apart between release points during June ,gave the greatest parasitism level, highest reduction of damage and highest cane yield compared to the distance (25-35 m) apart and control. Five releases of *T. evanescens* at rate of 30 000 individuals/fed with distance 20 meters apart between release points and 10 day intervals from May 20th to July 10th achieved higher egg parasitism (93.70 and 95.25%), lower damage (4.2 and 5.4%) by sugarcane borer and higher cane yield (55.20 and 58.50 ton/fed) in both spring and ratoon planted canes. Insignificant differences were found between the effecacies of both four and three of releases. Meanwhile, one (single) release of parasitoid led to lower parasitism rates (75.77 and 78.63%), higher damaged cane (12.5 and 15.7%) and produced lower cane yield (45.70-and 47.60 ton/fed.) compared to other releases. Therefore, it is recommended that *T. evanescens* should be released three–five times at the rate of 45000 individuals/fed. at 10 days intervals, with a distance of 15 m apart between release points to achieve high control levels with the parasitoid *Trigogramma* against the sugarcane borer in sugar cane fields in Menia region.

Key Words: *Trichogramma evanescens, Chilo agamemnon*, Sugarcane, Release, Control, Egypt.

INTRODUCTION

Sugarcane (*Saccharum officianrum* L.) is considered an economic crop in Egypt. Production of sugarcane is affected by insect pests, which reduce quantity and quality of sugarcane plants, the lesser sugarcane borer (LSB), *Chilo agamemnon* Bles., is a chronic pest of sugarcane in Egypt. This pest causes damage in sugarcane ranges from 15–20% reduction of sugar productivity (Tohamy 1999). This pest develops 3-4 annual generations from third week of May until the third week of November in sugarcane fields in Minia region. *Trichogramma evanescens* West. is the only egg parasitoid encountered and since the 1990s, it was used as a biological control agent against LSB in sugarcane fields and reduced the damage by this pest in Middle and Upper Egypt (Abbas *et al.* 1991 and 1996, Tohamy 2002). However, in the last few years, this pest caused economic damage in many areas of sugarcane plantations in Minia region, where one release by this parasitoid became not adequate to reduce the high infestation by LSB and in addition to the applications of insecticides to control the soft scale insect, *Pulvinaria tenuivalavata* in sugarcane field. For this reason, there is a need to develop and implement biological control program for sugarcane borer in this area.

Despite the widespread use of *Trichogramma*, there were relatively few cases where the successful control of a pest can be unequivocally ascribed to releases of this parasitoid. There were many documented failures of *Trichogramma* releases despite few notable successes (Li 1994). However, Smith, 1994, reported that the variable success of *Trichogramma* field releases can be attributed to a number of factors which includes: pesticide applications; weather conditions at the time of release; lack of host parasitoid synchrony and the quality of the release. According to Sithanantham 1980 ; Hassan 1994; Pham Binh Quyen *et al.* 1994b, the timing of releasing , number of parasites per unit, distance between releasing points and number of releases were limited based on the density of *Chilo* eggs in the first broods; or density of trapped adult by light or pheromone traps (Tohamy 2002b).

On the other hand, Varadharajan (1980), in India showed that the best timing for releases of *T. australicum* to control *Chilo indicus* on sugar-cane was investigated on the basis of larval activity where, the pest was found to be more active in the hot than in the cold months. He also showed that 12 releases each of 10 000 parasites/acre were usually adequate, but numbers and timing of releases had to be adapted according to the incidence of *C. indicus*. A calendar of releases is proposed in which the timing of releases varies regularly according to the month of cane planting; usually releases started on the third month after planting, and 2 releases/month are required on the second, third and fourth month after commencement and again in the following April, May and June (whatever the planting month) and sometimes in July also, which are the hottest months. El-Heneidy *et al.* (1991), indicated that when the parasitoid, *T. evanescens* release was synchronized with the appearance of the first egg masses of *C. agamemnon,* percentage parasitism by *T. evanescens* was 2-5 times that in untreated fields. Hassan (1994), mentioned that the first release should be timed to insure the presence of active *Trichogramma* in the field at the time when the first pest eggs are being laid.

Aim of the present study is to improved technique for biological control program against LSB using the parasitoid *T. evanescens* by choosing right timing and number of efficient releases in order to reduce the damage by the pest and to increase the yield.

MATERIALS AND METHODS

Field experiments:

Three field experiments were conducted at Mallawi region, Minia Governorate, during the sugarcane growing seasons 2005/06 and 2006/07 to investigate the effects of timing, distances and number of releases of the egg parasitoid, *T. evanescens* against the lesser sugarcane borer(LSB), *C. agamemnon* on the yield of the spring and ratoon of sugarcane crops .The chosen fields were prepared and planted with the recommended sugarcane variety, G.T. 54/9 on March 20th 2005 .Complete randomized block design was used in four replicates. All normal agriculture practices were carried out in the releasing plots and the plants were left to natural infestation during the seasons of study in the three experiments. The egg parasitoid was obtained from *Trichogramma* Research Laboratory in Mallawi Agricultural Research Station, Plant Protection Research Institute, Agricultural Research Center, Giza.. Production of *Trichogramma* parasitoid on eggs of *Sitotroga cereelella* (Olivier) was performed by Tohamy (2002a). Releasing card included about 3000 parasitized eggs in three age groups, each of 1000 parasitized eggs, allowing adult emergence of *Trichogramma* available for longer period in the sugarcane fields. The releasing card was placed on the leaves of the upper parts of the sugarcane by 20 meters distances, *i.e.* 30 cards/feddan/release. Two feddans were used as control and separated by about 500 m from the experimental fields. No releases or other control measures were performed in the control plots.

Effect of releasing date of *Trichogramma*

To determine the proper timing of releasing the egg- parasitoid, an area of about 28 feddans, at Kolba village, Mallawi region was divided into seven equal plots(7 fed/each). Each plot was far apart 100 m from each other to reduce movement of wasps among treatments .Each plot contained 4 subplots (1.75 feddans each) four subplots were randomly chosen. Number of 30000 egg parasitoids/fed. (10 cards/fed) was released, one time, in seven different dates; 20/5, 5/6, 20/6, 5/7, 20/7, 5/8 and 20/8 in the replicates of the first, second , third , fourth ,fifth , sixth and seventh plot , respectively, at distantce 20 meters apart between release points in all treatments. The first date for wasp releasing occurred after the first moth of the pest trapped by electrocuting light traps. The second, third and fourth dates of wasp releasing were carried out during the first generation of LSB, while the fifth, sixth and seventh dates were during the second generation of this pest.

Effect of *Trichogramma* releasing distance:

To determine proper releasing distances of the egg- parasitoid, *T. evanescens* , an area of about 30 feddans, at Kloba village, Mallawi region, were divided into six equal plots (5 fed. each). Each far apart 200 m from the other. Each plot contained 4 subplots each of 5250 m^2. Four plots were randomly chosen. The parasitoid was released one time in June (before and during egg peaks of the first generation of LSB) at a height of 70 cm above the ground, at various distances from the wasp release points to control LSB (10, 15 ,20, 25, 30 and 35 meters) at different rates of 40 cards(120 000); 20 cards (60 000); 10 cards(30 000) ; 7 cards 21 000; 5 cards (15000) and 4 card (12000 individuals) per fed. in plots of the first , second , third , fourth, fifth , sixth parts, respectively. The control was set 500 m away from the *Trichogramma* releasing plots.

Effect of number of *Trichogramma* wasp releases:

Another area of about 60 feddans was selected in Seif Basha village, Mallawi region and divided into five equal parts (12 feddans each). Each part contained 4 plots (3 feddans each). Factors studied in this case were one, two, three, four and five releases of the egg parasitoid. The egg parasitoid cards were released at rate of 3000 individuals/fed (10 cards/fed.) by 20 meters distances between release points, at 10 day intervals, (after 70 days sugarcane old) in the replicates of the first, second, third, fourth and fifth part, respectively. The releasing process was carried out during the first and the second generations of LSB. *Trichogramma* (egg parasitoid bags) were released five, four, three, two and one time in the considered parts, respectively.

Three electrocuting light traps contained four lamps fluorescent with 160 volt were placed, directed and distributed at a regular distance (70 meter) in released fields .The same number of traps were distributed in the control fields and hanged on metallic bar with a roller at 40 cm above the plants and raised weekly according to the rate of plant growth to keep them 40 cm higher than the plants. Flight activity of sugarcane moth (males and females) captured by electrocuting light traps was weekly recorded starting from May to November in both seasons in wasp- treated and untreated area (control).

Sampling techniques and evaluation measurements:

The parasitoid survey began 10 days after releasing in May. Weekly samples of 25 stalks in each plot were randomly checked, egg masses of sugarcane borer were collected by cutting the leaves and placed individually into glass tubes and transferred to the laboratory. The total number of *Chilo* eggs and both parasitized and non parasitized eggs were counted in order to determine parasitism percent in all treatments using the following formula:

$$\% \text{ of parasitism} = \frac{\text{No of parasitized eggs}}{\text{No of parasitized and non parasitized eggs}} \times 100$$

Field releases of *Trichogramma* were evaluated by measuring sugarcane borer infestation, percent crop damage and economic return.

At harvest time of the three experiments, samples of 100 stalks were randomly chosen from each plot/treatment, each stalk was carefully examined to determine the following parameters: 1-total number of joints, 2- total number of bored joints, 3-number of girdled joints, 4- number of dead tops and 5- percentage of total infestation using the following formula:

$$\% \text{ Total of infestation} = \frac{\text{bored joints + girdled joints + dead tops}}{\text{Total of joints}} \times 100$$

Percentage reduction of LSB infestation was calculated and recorded as follows:

$$\% \text{ Reduction} = C - T/C \times 100$$

Where: C = Mean total number of infested joints in the control.
T = Mean total number of infested joints in the treatment.

Also, cane yield of each plot/treatment/experiment was weight and the yield per feddan (ton/fed.) in each treatment was calculated in the released and non-releases areas (control).

Statistical analysis

Results were statistically analyzed by ANOVA according to Duncan's (1955) and SAS (1996) (computer program).

RESULTS AND DISCUSSION

Data in Table (1) showed parasitism rate among *Chilo* eggs by *T. evanescens* in different dates (timing) of releases. The parasitism started in June after five days from releases, increased gradually and reached a maximum in October and November in spring and ratoon plantations in treated plots in May 20th, June 6th and June 20th .While the natural parasitism started comparatively late during July and ended as a maximum in October and November in treated plots in August 5th and August 20th and non–treated ones in both seasons. The percentage of parasitism of *Chilo* egg masses ranged between 67.7– 90, 65–100, 63.7–100; 0–100; 0–91.4; 0–86.0; 0–86.0; 0–80.0 and 0–72.7% in the spring plantation, and ranged between 70–92.3; 68.0-100; 66.7-100; 0–100; 0–91.5, 0–88.5; 0-86.0 and 0–75.7% in ratoon sugarcane when the parasitoid was released on May 20th, June 6th and June 20th ; July 5th ; July 20; August 5th; August 20th and non released ones(control), respectively. Highest mean percentages of parasitism (83.78, and 81.50%) were commonly recorded in plots treated in early dates: June 6 and June 20 (during or before a peak of moth or egg masses) of the first generation of *C. agamemnon* in the spring plantation, but it was 85.95 and 83.51% in the ratoon sugarcane. Lowest mean percentages parasitism (54.10 and 50.31%) and (58.15 and 54.71%) occurred, when egg parasitoid released in late dates, August 5th and 20th (during second generation of *C. agamemnon*)in spring and ratoon canes, respectively. On the other hands, the obtained data showed that there was a significant difference between the timing of *Trichogramma* releases during the first generation (May 20th to July 5th) and both releases during the second generation of *C. agamemnon* (July 20th to August 20th) and the control ones. The high level of egg parasitism by *T. evanescens* in early release might be due to presence of the parasitoid during the period of laying egg masses by *C. agamemnon* in the first generation, or while the low level of egg parasitism probably due to absence of the parasitoid during the first broods of pest, in addition to different weather conditions.

Generally, such results were in agreement with those reported by Alba (1991) who found that releases of *Trichogramma* spp. against *Tetramoera schistaceana,Chilo infuscatellus* and *Scirpophaga intacta* on sugarcane in the Philippines at a rate of 100 000 adult parasitoids/ha resulted in 70.35% parasitism compared with 14.49% parasitism in untreated fields. When releases were synchronized with the appearance of the first borer egg, the rate of parasitism increased to 87.5% and the borers' infestation decreased to reach 4.78% in treated fields compared with 77.7% in untreated fields. Gracia and Tavares (1994) concluded that the duration of parasitoid development or egg to adult developmental time and longevity, decreased as temperature increased in hot months and then the parasitism percentage increased. Berithaupt (1994) showed that release of *Trichogramma* with high population density (140,000 wasps per hectare) in the field at an early growth corn stage or beginning of the season (of 40 days after seeding) increased the number of beneficials in the field in order to prevent the build up of the Asian corn borer population.

Data in Table (2) represented percentage of parasitism at different distances from wasps release points. The percentages of parasitism varied from 75.0–100; 73.7–100; 70–100; 66.7–100; 50–90.9; 40–87.8% in released fields in distances of 10, 15, 20, 25, 30 and 35 meters apart from release points in the spring sugarcane plantation, respectively. Similar trends were obtained in the ratoon sugarcane, where the highest mean percentages of egg masses parasitism (88.95 and 90.78 %) were obtained from the plots which released by 10 meters distance with no significant differences among effectiveness of releases distances, 10, 15 and 20 meters in both seasons. Lowest mean percentage of parasitism was recorded in releasing distances 30 and 35 meters apart, where it was 68.07 and 64.43 % in the first season and 71.27 and 68.07 % in the second season. The parasitism can be increased by decreasing the releases distance, probably due to saving effort and time of parasitoid in searching beside shorter developmental time of parasitoid (suitable environmental conditions that increased numbers of the parasitoid. Similar results were obtained by Hirai *et al.* (1996) and Rachappa and Naik (2004). They indicated that when *Trichogramma* released in narrow distances from release point (15 m) to control sugarcane borers, the percentage of parasitism on egg- masses was increased compared with those obtained from distances beyond 15 m and up to 30 m.

Data in Table (3) showed efficacy of releases number of *Trichogramma* on parasitism rates of *C. agamemnon* eggs. Five inductive releases of egg parasitoid at rate of 30 000 individuals /fed sites of 20 meters apart from release points ,at 10 day intervals , after 70 days sugarcane old (the third week of May), gave the maximum mean percent parasitism on *Chilo* egg masses (93.70 and 95.25%), while the next highest percentages of parasitism (92.93 and 94.53%) were obtained from plots which released four times followed with 92.27 and 94.0 % in plots treated three times compared to plots which treated one time (75.77 and 78.63%) and non treated (43.27 and 49.60%) in spring and ratoon sugarcane , respectively. No significant differences were found in egg parasitism between the five times released plots and both those released four and three times in both seasons, while the differences were highly significant between the one release and other more than one release of *Trichogramma*. These results are in accordance with those observed by Pham Binh Quyen *et al.*(1994) who indicated that when *T. chilonis* was released five times with dose 500,000 individuals per hectare, they attacked large numbers of egg masses of sugarcane borers, the parasitoid remained in the field from the end of May onward appeared to be still efficient in June and in September to record 79.3% as overall egg parasitism.

Data in Table (4) and Fig. (1) represented the total infestation by *C. agamemnon* , expressed as percent of bored joints , girdled joints and dead tops after harvest time of sugarcane by the end of season in different timing of *Trichogramma* releases in both spring and ratoon sugarcane. Results showed that the plots which released by *T. evanescens* in June 6 recorded the lowest cumulative percentages (6.80 and 7.50%) of total of infestation by *C. agamemnon* with the highest percentage of infestation reduction (63.44 and 65.43 %); in spring and ratoon sugarcane, respectively .While the released plots in August 5 and August 20 gave the

Table (1): Parasitism% of *T. evanescens* on *C. agamemnon* eggs /400 sugarcane plants in different timings of releases, Mallawi region, Minia, Middle Egypt, 2005/2006 and 2006 /2007seasons.

Releasing	Spring planting (2005/2006)							Ratoon (2006/2007)						
Timing	June	July	Aug.	Sep.	Oct.	Nov.	Mean	June	July	Aug.	Sep.	Oct.	Nov.	Mean
May 20	67.7	70.4	75.0	77.5	85.7	90.0	77.55^{b}	70.0	73.6	78.2	80.0	87.5	92.3	8027^{b}
June 6	65.0	75.7	80.0	85.3	96.7	100	83.78^{a}	68.0	77.5	86.5	88.7	95.0	100	85.95^{a}
June 20	63.7	72.8	77.2	83.7	94.0	100	81.50^{a}	66.7	75.0	81.2	85.0	93.2	100	83.51^{a}
July 5	00.0	66.7	75.8	80.7	92.3	100	69.25^{c}	00.0	68.4	79.5	83.5	92.0	100	70.56^{c}
July 20	00.0	60.0	65.4	75.7	84.2	91.4	62.78^{d}	00.0	65.0	73.5	80.0	86.4	91.5	66.07^{c}
Aug. 5	00.0	40.0	50.0	66.7	81.9	86.0	54.10^{e}	00.0	45.2	60.0	70.3	84.9	88.5	58.15^{d}
Aug.20	00.0	35.7	45.2	65.0	75.7	80.3	50.31^{ef}	00.0	43.6	50.0	68.7	80.0	86.0	54.71^{d}
Control	00.0	37.5	40.7	60.0	65.3	72.7	46.03^{f}	00.0	40.0	45.2	63.5	66.7	75.7	48.51^{e}

Within the same column, the mean values followed the different are significantly at (P< 0.05), as determined by Dunca^{n}'s (1955) multiple rang test.

Table (2): Parasitism % of *T. evanescens* on *C. agamemnon* egg masses/400 sugarcane plants in different distances between wasps release points, Mallawi region, Minia, Middle Egypt, 2005/06 and 2006/07 seasons.

Releasing	Spring planting (2005/2006)							Ratoon (2006/2007)						
Distance	June	July	Aug.	Sep.	Oct.	Nov.	Mean	June	July	Aug.	Sep.	Oct.	Nov.	Mean
10 m	75.0	83.6	87.8	92.3	95.0	100	88.95^{a}	75.0	85.0	88.7	96.0	100	100	90.78^{a}
15 m	73.7	81.7	85.7	90.7	94.0	100	87.63^{a}	77.5	80.0	87.8	93.4	96.0	100	89.07^{a}
20 m	70.0	77.8	80.0	85.7	91.7	100	84.20^{a}	75.0	76.8	85.7	90.0	94.3	100	86.94^{a}
25 m	66.7	70.0	75.0	80.0	83.3	100	79.07^{b}	68.4	73.5	77.5	82.6	85.0	100	81.16^{b}
30 m	50.0	50.0	60.0	70.0	87.5	90.9	68.07^{c}	50.0	57.1	66.7	75.0	86.3	92.5	71.27^{c}
35 m	40.0	50.0	57.1	66.7	85.0	87.8	64.43^{c}	50.0	60.0	63.2	70.0	80.0	90.9	68.07^{c}
Control	00.0	37.0	50.0	55.5	64.7	73.5	46.09^{d}	00.0	33.7	47.5	60.0	66.7	77.7	47.60^{d}

Within the same column, the mean values followed the different are significantly at (P< 0.05), as determined by Dunca^{n}'s (1955) multiple rang test.

Table (3): Parasitism of *T. evanescens* on *C. agamemnon* egg masses per 400 sugarcane plants in different times and wasps releases, Mallawi region, Minia, Middle Egypt, 2005/06 and 2006/07 seasons.

Releases	Spring planting (2005/2006)							Ratoon (2006/2007)						
Number	June	July	Aug.	Sep.	Oct.	Nov.	Mean	June	July	Aug.	Sep.	Oct.	Nov.	Mean
One	60.0	66.7	70.0	80.0	85.7	92.3	75.77^{c}	65.0	70.0	77.5	80.0	83.3	96.0	78.63^{c}
Two	70.0	77.5	80.0	87.8	94.0	100	84.88^{b}	68.5	75.0	85.7	90.9	94.0	100	85.68^{b}
Three	70.0	85.7	92.7	95.0	97.0	100	90.07^{a}	75.0	91.5	94.3	96.0	97.3	100	92.39^{a}
Four	73.5	89.8	94.3	96.0	100	100	92.27^{a}	76.0	93.2	96.0	97.8	100	100	94.00^{a}
Five	75.0	93.9	96.0	97.3	100	100	93.70^{a}	78.5	96.0	98.0	98.5	100	100	95.25^{a}
Control	00.0	33.7	40.0	50.0	66.7	69.2	43.27^{d}	00.0	47.0	55.6	60.0	65.0	70.0	49.60^{d}

Within the same column, the mean values followed the different are significantly at (P< 0.05), as determined by Dunca^{n}'s (1955) multiple rang test.

Table (4): Percentage of infestation (bored joints + girdled joints +dead tops) caused by *C. agamemnon* and cane yield in relation to different timing of *Trichogramma* releases, Mallawi region, Minia, Middle Egypt, 2005/06 and 2006/07 seasons.

Releasing	Infestation %			Reduction % than control			Cane yield (ton/ fed.)		
Timing	Spring	Ratoon	Mean	Spring	Ratoon	Mean	Spring	Ratoon	Mean
May 20	8.20^{cd}	10.60^{cd}	9.40^{cd}	55.91^{c}	51.15^{c}	53.53^{c}	43.8^{bc}	46.0^{bc}	44.90^{bc}
June 6	6.80^{e}	7.50^{e}	7.40^{e}	63.44^{a}	65.43^{a}	64.44^{a}	47.2^{a}	48.6^{a}	47.90^{a}
June 20	7.50^{e}	8.50^{e}	8.10^{e}	59.68^{b}	60.63^{b}	60.16^{b}	45.5^{ab}	47.0^{ab}	46.25^{ab}
July 5	9.20^{c}	12.00^{c}	10.60^{c}	50.54^{d}	41.70^{d}	46.12^{d}	43.2^{cd}	45.6^{cd}	44.40^{cd}
July 20	10.50^{c}	13.50^{c}	12.00^{c}	43.55^{e}	37.79^{e}	40.67^{e}	42.8^{de}	44.2^{de}	43.50^{de}
Aug. 5	14.00^{b}	16.70^{b}	15.35^{b}	24.73^{f}	23.04^{f}	23.89^{f}	41.8^{e}	43.6^{e}	42.70^{e}
Aug.20	15.20^{b}	18.30^{b}	16.75^{b}	18.28^{g}	15.67^{g}	16.98^{g}	39.6^{e}	41.4^{e}	40.50^{e}
Control	18.60^{a}	21.70^{a}	20.15^{a}	-	-	-	37.3^{f}	39.2^{f}	38.25^{f}

Within the same column, the mean values followed the different are significantly at (P< 0.05), as determined by Dunca^{n}'s (1955) multiple rang test.

highest total infestation (14.0 and 16.70%) and (15.20 and 18.30 %) with the lowest percentage of damage reduction (24.73 and 23.04 %) and (18.28 and 15.67%) over the control plots in both seasons, respectively. Data in Table (4) recorded significant differences in mean percentage of total infestation among timing of parasitoid release in June and both releases in July 20th; August 5th, August 20th and control plots. However, *Chilo* damage in released fields in August did not differ from control plots, probably due to absence the parasitoid during the first broods of pest and high plant infestation by Noctuidae eggs and different climate.

The highest cane yield (46.2 and 47.6 ton /fed.) was obtained from *Trichogramma* released on June 6 followed by 45.5 and 47.0 ton/fed. in releasing time of June 20. While the lowest cane yield (41.6 and 43.4 ton/fed.) was observed in plots, which released lately in August, where *T. evanescens* was not found on the 1st generation of LSB and its behavior is not active at low temperature in spring time. These factors are suggesting the necessity for further research on the relationship between phonology and behavior of parasitoids in relation with selection of useful biocontrol agents. Similar results were obtained by Abbas (1997) who showed that sugarcane plants in Egypt infested with *C.agamemnon* and treated with *T. evanescens* had higher yields than untreated plants during 1987-1996. He also found that *T. evanescens* released once each year early in the season at 20 000/feddan [1 feddan =0.42 ha] reduced infestation by 50-79% at the end of the season. Berithaupt (1994) showed that an early releasing of 140,000 *Trichogramma* per hectare against Asain corn borer reduced significantly the number of pest larvae per plant and resulted in a higher yield.

Close analysis of the previous result would lead to a practical use for controlling of *C.agamemnon* by releasing *T. evanescens* in the sugarcane field in the proper time. Population of *Chilo* eggs reached highest level in the second generation which appeared during July-September, However, it is suggested that release of parasiteoit during the first generation of May-July could suppress the population of the second generation which considered the most serious one.

Data in Table (5) and Fig. (2) showed that the total infestation by *C. agamemnon* decreased while cane weight and total yield increased with decreasing the distance among *Trichoramma* release points. The total infestation index of sugarcane borer was significantly lower in released plots with distance 10–20 meters than with distance 25 -35 meters apart from wasp release points and control plots. It was 4.4, 5.0, 6.2, 9.8, 11.2 and 12.7% as compared to 17.3% in the control in the spring sugarcane and it was 6.0, 6.8, 8.6, 12.0, 12.6, 13.3% as compared to 21.7% in the control in ratoon sugarcane in released plots by distances 10, 15, 20, 25, 30 and 35 m, respectively. On the other hand, releasing of egg parasitoid, *T. evanescens* at rate of 30000 individuals/fed with distance 10 meters apart among release points during June, gave the highest damage reduction by this pest (74.57 and 72.30%) followed with 71.10 and 68.88% in releasing distance 15 meters and 64.16 and 60.03 % in releasing distance 20 meters in spring and ratoon canes, respectively. compared with the control plots. While the lowest infestation reduction (26.60 and 38.61%) was recorded in parasitoid release plots in sites of 35 meters apart from wasp release points with no significant differences with distances 30 and 25 meters in both seasons, respectively.

Also, egg parasitoid released in distance 10–20 meters apart from release points resulted a significantly higher sugarcane yield compared to distance 25-35 m and control plots, where it ranged between 44.80–47.30 ton/fed in the spring plantation and 45-49.10 ton/fed in ratoon sugarcane. Similar results were obtained by Rachappa and Naik (2004).

Table (5): Percentage of infestation (bored joints + girdled joints + dead tops) caused by *C. agamemnon* and cane yield in relation to different distances of *Trichogramma* releasing points, Mallawi region, Minia, Middle Egypt, 2005/06 and 2006/07 seasons.

Releasing Distance	Infestation %			Reduction % than control			Cane yield (ton/ fed.)		
	Spring	Ratoon	Mean	Spring	Ratoon	Mean	Spring	Ratoon	Mean
10 m	4.4^{e}	6.0^{d}	5.20^{d}	74.57^{a}	72.30^{a}	73.44^{a}	47.30^{a}	49.10^{a}	48.20^{a}
15 m	5.0^{d}	6.8^{d}	6.15^{d}	71.10^{a}	68.66^{a}	69.88^{a}	47.00^{a}	48.70^{a}	47.85^{a}
20 m	6.2^{d}	8.6^{d}	7.90^{d}	64.16^{b}	60.03^{b}	62.09^{b}	44.80^{ab}	45.60^{ab}	45.20^{ab}
25 m	9.8^{c}	12.0^{c}	10.90^{c}	43.35^{c}	44.70^{c}	44.03^{c}	43.30^{bc}	44.00^{bc}	43.65^{bc}
30 m	11.2^{b}	12.6^{b}	11.90^{b}	35.26^{d}	40.02^{d}	37.64^{d}	43.00^{cd}	43.40^{cd}	43.20^{cd}
35 m	12.7^{b}	13.3^{b}	13.00^{b}	26.60^{e}	38.61^{d}	32.60^{d}	42.10^{de}	43.00^{de}	42.55^{de}
Control	17.3^{a}	21.7^{a}	19.50^{a}	-	-	-	37.50^{f}	39.50^{f}	38.50^{f}

Within the same column, the mean values followed the different are significantly at ($P< 0.05$), as determined by Dunca^{n}'s (1955) multiple rang test.

Table (6): Percentage of infestation (bored joints+girdled joints+dead tops) caused by *C. agamemnon* and cane yield in relation to different times number of *Trichogramma* releases, Mallawi region, Minia, Middle Egypt, 2005/06 and 2006/07 seasons.

Releases Number	Infestation %			Reduction % than control			Cane yield (ton/ fed.)		
	Spring	Ratoon	Mean	Spring	Ratoon	Mean	Spring	Ratoon	Mean
One	12.5 ^{b}	15.7 ^{b}	14.10 ^{b}	38.73 ^{d}	32.62 ^{d}	35.68 ^{d}	45.70 ^{c}	47.60 ^{c}	46.65 ^{c}
Two	8.6 ^{c}	10.7 ^{c}	9.65 ^{c}	57.84 ^{c}	54.08 ^{c}	55.96 ^{c}	51.00 ^{b}	53.40 ^{b}	52.20 ^{b}
Three	6.0 ^{c}	7.4 ^{d}	7.75 ^{d}	70.59 ^{b}	68.24 ^{b}	69.42 ^{b}	53.60 ^{b}	55.00 ^{a}	54.30 ^{a}
Four	5.5 ^{d}	6.7 ^{d}	7.70 ^{d}	73.03 ^{b}	71.24 ^{b}	72.14 ^{b}	54.00 ^{a}	55.40 ^{a}	54.70 ^{a}
Five	4.2 ^{d}	5.4 ^{d}	6.55 ^{d}	79.41 ^{a}	76.82 ^{a}	78.12 ^{a}	55.20 ^{a}	56.50 ^{a}	55.85 ^{a}
Control	20.4 ^{a}	23.3 ^{a}	21.85 ^{a}	-	-	-	38.70 ^{d}	40.10 ^{c}	39.60 ^{d}

Within the same column, the mean values followed the different are significantly at ($P < 0.05$), as determined by Dunca"'s (1955) multiple rang test.

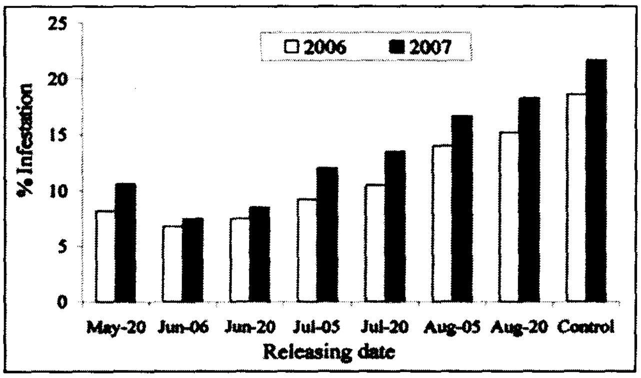

Fig. (1): Percentage of infestation caused by *C. agamemnon* in relation to different dates of *Trichogramma* releases, Mallawi, Minia, 2005–007.

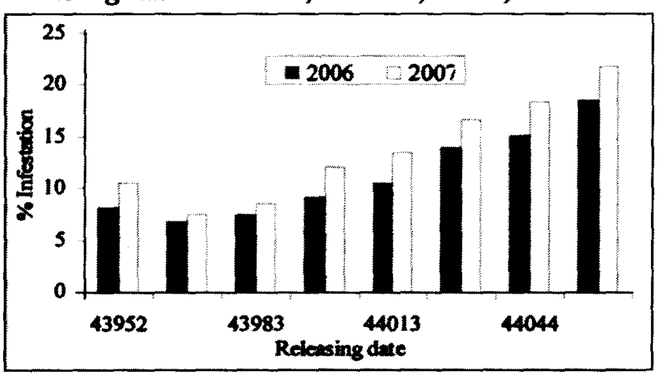

Fig. (2): Percentage of infestation caused by *C. agamemnon* in relation to different releases distances of *Trichogramma*, Mallawi, Minia, 2006-2007.

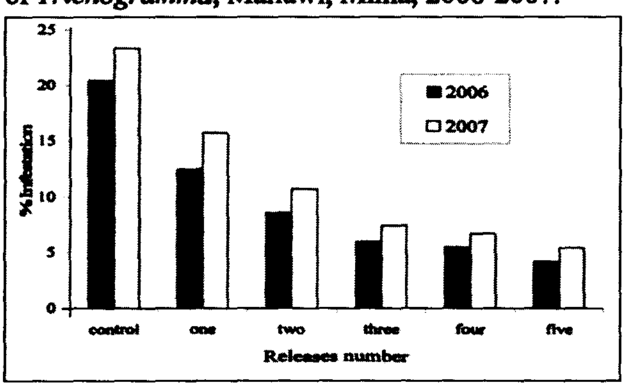

Fig (3): Percentage of infestation caused by *C. agamemnon* in relation to different times number of *Trichogramma* releases , Mallawi , Minia 2006–07.

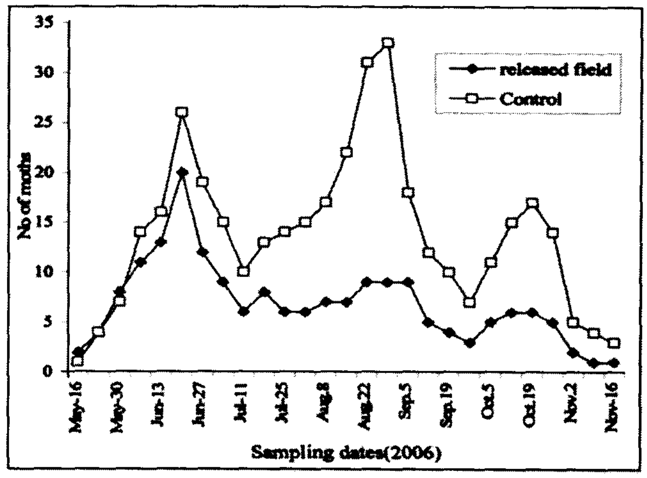

Fig. (4): Percentage of infestation caused by *C. agamemnon* in relation to different dates of *Trichogramma* releases, Mallawi, Minia, 2005–06.

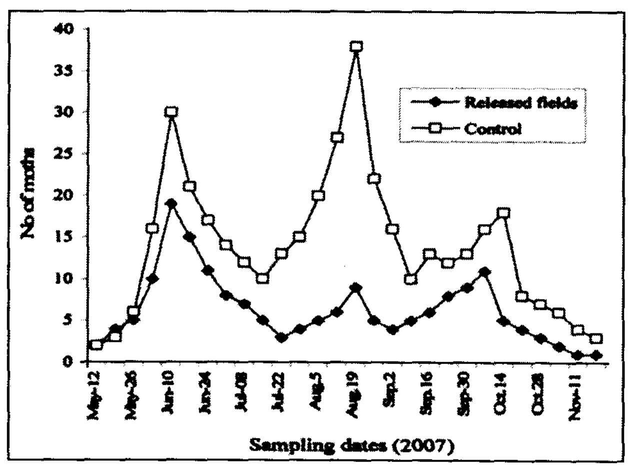

Fig. (5): Percentage of infestation caused by *C. agamemnon* in relation to different releases distances of *Trichogramma*, Mallawi, Minia, 2006-07.

The obtained results in Table (6) and Fig. (3) indicated that increasing number of release of *T. evanescens* led to lower sugar cane damage by *C. agamemnon* and highest weight and yield in both seasons. Five releases of *T. evanescens* at rate of 30000 individuals/fed with distance 20 meters apart between release points, at 10 day intervals from May, 20th to July, 10th, reduced the total infestation of sugarcane borer expressed as percent of bored joints, girdled joints and dead tops after harvest time of sugarcane from 20.4 and 23.3% in the control plots to 4.2 and 5.4 % in the spring and ratoon sugarcane plantings, respectively. The single release of 30 000 individuals /fed in June, 10th recorded the highest total infestation by this pest, where it was 12.5 and 15.7% in the spring and ratoon canes, respectively. The highest percentage reduction (79.41 and 76.82%) in *Chilo* infestation was observed in five releases of the egg parasitoid in both seasons, respectively without significant differences between effectiveness of four and three times releases. Statistical analysis showed that there were significant differences in cane damaged by sugarcane borer among one release by *Trichogramma* and other treatments in the tested seasons.

Also, the present study showed that the highest cane yield was achieved in plots treated with three to five times of *Trichogramma* releases, where it was 55.20, 54.0 and 53.60ton/fed in the spring plantation and 58.50 and 55.40 and 55.0 ton/fed in ratoon sugarcane in the five, four and three times releases, respectively. While the lowest cane yield was obtained from the one time release as compared to the four and three releases, where it was 45.30 and 47.60 ton/fed in both seasons, respectively.

Similar results were obtained by Rao (1980), Singh *et al.* (2001) and Shenhmar *et. al.* (2003 and 2005). Abbas *et. al.* (1991), showed that the release of *T. evanescens* at the rate of 50 000 adults/800 m superscript 2 into sugarcane fields in Egypt in 1984-85 to control *C. agamemnon* resulted in 100% parasitism of eggs of *C. agamemnon* 24 h after release. A single release of 46 000 adults/feddan reduced the infestation of joints and stalks by 28 and 20%, respectively. Three releases in May, of 20 000 adults/feddan each, resulted in 55 and 38% reductions, respectively. Six releases through May and June, of 30 000 adults/feddan, resulted in 61 and 45% reductions, respectively. Manisegaran (2004) stated that, six inundative releases of the parasitoid, *Trichogramma chilonis* through 5 to 7- days old parasitized eggs of *Corcyra cephalonica* colonized at 75000/ha at 15 days interval from second week of April 2001 onwards, reduced the incidence and intensity of internodes borer, *Chilo sacchariphagus* to 20.5 and 28.2% compared with 61 and 73.9% in farmers' practice where no release of parasitoid and no sprays were made. Higher cane weight (1.72 kg) and yield (121.5 t/ha) was recorded in parasitoid released plots and resulted in 35.6% increase in yield over the farmers' practice. Also, Rajendran (2006) showed that release of *T. chilonis* at 2.5 CC/ha 6 times at fortnightly intervals after 5 months of planting and harvesting at the 12 month without delay increased the millable canes and yield of the crop by 36.45% and reduced the infestation of the crop by shoot borers (*Chilo infuscatellus*).

Generally, the use of *T. evanescens* five times at rate of 30000 to 120000 individuals /fed from mid May to mid July at 15 day intervals with distant 10-20 m from release points resulted in reduced pest damage (below economic injury level), significantly increased yield, reduced costs of pest control, conservation of natural enemies maintaining resource quality and avoiding environmental and other risks to human and animals.

Fig. (4) showed the seasonal abundance of *C. agamemnon* , expressed as numbers of moths captured by electrocuting light traps in sugarcane treated with egg parasitoid and non treated (control).The moths were collected from the light traps starting May 16th until November16th in spring sugarcane plantation and from May 12th to November 17th in 1st ratoon cane Three peaks of moths were recorded in June 20th (20 and 26 moths); August 29th (9 and 33 moths) and October 19th (6 and 17 moths) in treated and control sites , respectively in 2006 season; but in 2007 season the three peaks were found on June 10th (19 and 30 moths); August 19th (11 and 38 moths) and October 7th and 14th (10 and 18 moths) in treated and control sites, respectively. The results presented in Fig. (5) clarified that *C. agamemnon* has three annual generations based on number of moths captured by electrocuting light traps in sugarcane treated with egg parasitoid and non treated (control), starting from May 16th to July 11th ; July 2nd to September 26th and September 19th to November 16th in season 2006 and from May 12th to July 15th in the control field and to July 22nd in released field ; July15th to September 9th in the control and to September 2nd in the released field and from September 2nd to November 17th, respectively in 2007 season. The total number of moths in the second and third generation of the pest was lower in the parasitoid released fields than the control ones. Reduction in moths catches in treated plots resulted in decreasing number of egg of *C. agamemnon* and increased the percentage of parasitism by *Trichogramma* in treated plots compared to the control ones. The total numbers of moths captured by electrocuting light traps; the total number of host eggs, and plant age were the most important factors affecting the density of the parasitoid. Similar results were obtained by Tohamy (2002 b).

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الملخص العربي

أفضل الظروف لإطلاق طفيل *Trichogramma evanescens* **West.** لمكافحة دودة القصب الصغرى *Chilo agamemnon* **Bles.** في حقول قصب السكر فى محافظة المنيا

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تم عمل هذه الدراسة خلال موسمى ٢٠٠٥/٢٠٠٦، ٢٠٠٦/ ٢٠٠٧ في منطقة ملوي بمحافظة المنيا لتقييم تأثير أفضل ميعاد لإطلاق طفيل التريكوجراما وانسب المسافات بين نقاط الإطلاق وعدد مرات الإطلاق المناسبة لتقليل الضرر بدودة القصب الصغيرة في حقول قصب السكر الغرس والخلفة إلى مستوى أقل من الحد الاقتصادي الحرج وبالتالي زيادة الإنتاج وذلك لتطوير برنامج المكافحة الحيوية بهذا الطفيل ثم متابعة أسبوعية لفراشات هذه الآفة المصطادة بالمصايد الضوئية الصاعقة في حقول المعاملة بالطفيل مقارنة بالحقول غير المعاملة (كنترول). أوضحت النتائج أن إطلاق طفيل التريكوجراما في ٦يونيو (حول قمة الجيل الأول للآفة) أدى إلى الحصول على أعلى نسبة تطفل على بيض الآفة (٨٣,٧٨، ٨٥,٩٥%) وأعلى نسبة خفض للإصابة (٦٣,٤٤، ٦٥,٤٣ %)، وأعلى إنتاجية للمحصول (٤٧,٢، ٤٨,٦ طن/فدان) في كل من القصب الغرس والخلفة على التوالي . بينما إطلاق الطفيل خلال شهر أغسطس (خلال الجيل الثاني للآفة) قد حقق نسبة تتطفل (٥٠,٣١، ٥٤,٧١ %) ونسبة خفض في الإصابة (١٨,٢٨، ١٥,٦٧%) وإنتاجية في المحصول (٣٩,٦ ، ٤١,٤ طن/فدان). أيضا أوضحت النتائج أن إطلاق طفيل التريكوجراما بمعدل ٣٠-١٢٠ ألف طفيل/ فدان في مسافات من ١٠–٢٠ متر من نقط الإطلاق أدى إلى الحصول على أكبر نسبة تطفل على بيض هذه الآفة وأكبر نسبة خفض للإصابة، أعلى إنتاجية لمحصول لكل من القصب الغرس والخلفة وذلك بالمقارنة بإطلاق الطفيل على مسافات ٢٥–٣٥ متر من نقط الإطلاق والكنترول. كما أوضحت النتائج أن إطلاق طفيل التريكوجراما خمس مرات كل عشرة أيام ابتداء من ٢٠يونية حتى ١٠ يوليو وبمعدل ٤٥ ألف طفيل/فدان وعلى مسافة ١٥ متر من نقط الإطلاق أدى إلى الحصول على أعلى نسبة تطفل على بيض الآفة (٩٣,٧٠ ، ٩٥,٢٥%) واقل نسبة إصابة (٤,٢، ٥,٤%) ،أعلى إنتاجية للمحصول (٥٥,٢ ، ٥٨,٥ طن/فدان) بدون آي فروق معنوية بينها وبين تأثيرات إطلاق الطفيل بمعدل أربع وثلاث مرات في كلا الموسمين. لذا يتم التوصية بإطلاق طفيل التريكوجراما من ٣- ٥ مرة كل ١٠ أيام وعلى مسافة من ١٥ متر من نقط الإطلاق حسب شدة الإصابة عندما يكون عمر القصب ٧٠ يوم وبمعدل ٤٥ألف طفيل/فدان وذلك للحصول على برنامج متطور للمكافحة الحيوية يكون أكثر تأثيرا على تقليل الضرر بهذه الآفة.